

POWER OVER ETHERNET

**Power Sourcing Equipment
Parametric Test Suite
Version 2.2**

Technical Document



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MODIFICATION RECORD

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INTRODUCTION

Overview

The University of New Hampshire's InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard. This suite of tests has been developed to help implementers identify problems related to the functional and electrical characteristics of the Power Sourcing Equipment defined in the IEEE 802.3–2005 standard.

Note: Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other compliant devices. However, combined with satisfactory operation in the IOL's interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function well in most IEEE 802.3-2005 environments.

The tests contained in this document are organized in such a manner as to simplify the identification of information related to a test, and to facilitate in the actual testing process. Tests are organized into groups, primarily in order to reduce setup time in the lab environment. However the different groups typically tend to focus on specific aspects of device functionality. A three-part numbering system is used to organize the tests, where the first number indicates the clause of the IEEE 802.3 standard on which the test suite is based. The second and third numbers indicate the test's group number and test number within that group, respectively. This format allows for the addition of future tests to the appropriate groups without requiring the renumbering of the subsequent tests.

The test definitions themselves are intended to provide a high-level description of the motivation, resources, procedures, and methodologies pertinent to each test. Specifically, each test description consists of the following sections:

Purpose

The purpose is a brief statement outlining what the test attempts to achieve. The test is written at the functional level.

References

This section specifies source material *external* to the test suite, including specific sub-clauses pertinent to the test definition, or any other references that might be helpful in understanding the test methodology and/or test results. External sources are always referenced by number when mentioned in the test description. Any other references not specified by number are stated with respect to the test suite document itself.

Resource Requirements

The requirements section specifies the test hardware and/or software needed to perform the test. This is generally expressed in terms of minimum requirements, however in some cases specific equipment manufacturer/model information may be provided.

Last Modification

This specifies the date of the last modification to this test.

Discussion

The discussion covers the assumptions made in the design or implementation of the test as well as known limitations. Other items specific to the test are covered here.

Test Setup

The setup section describes the configuration of the test environment. Small changes in the configuration should be included in the test procedure.

Procedure

The procedure section of the test description contains the step-by-step instructions for carrying out the test. It provides a cookbook approach to testing, and may be interspersed with observable results.

Observable Results

The observable results section lists specific items that can be examined by the tester to verify that the DUT is operating properly. When multiple values are possible for an observable result, this section provides a short discussion on how to interpret them. The determination of a pass or fail for a certain test is often based on the successful (or unsuccessful) detection of a certain observable result.

Possible Problems

This section contains a description of known issues with the test procedure, which may affect test results in certain situations.

Group 1: Detection Characteristics

Scope: This group of tests verifies the electrical and functional characteristics during the detection mode of Power Sourcing Equipment.

Overview: These tests are designed to identify problems with IEEE802.3-2005 Clause 33 compliant devices. Specifically, the problems related to the functional and electrical characteristics of Power Sourcing Equipment's detection sequence.

33.1.1: PSE Location

Purpose: To verify that location of the Power Sourcing Equipment is valid.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.1, Figure 33-4 and Table 33-1.

Resource Requirements:

- Oscilloscope

Last Modification: December 21, 2005

Discussion: A PSE can be located with or on a link segment that is separate from the DTE/Repeater; These two locations are known as Endpoint PSE and Midspan PSE respectively. For an Endpoint PSE, detection and power can be applied with either the Alternative A or Alternative B pinouts. For a Midspan PSE, detection and power can only be provided on the Alternative B pinout. These pinouts are defined in the Table 33-1, reprinted below.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Conductor	Alternative A (MDI-X)	Alternative A (MDI)	Alternative B (All)
1	Negative VPort	Positive VPort	
2	Negative VPort	Positive VPort	
3	Positive VPort	Negative VPort	
4			Positive VPort
5			Positive VPort
6	Positive VPort	Negative VPort	
7			Negative VPort
8			Negative VPort

Table 33-1 – PSE pinout alternatives

Procedure:

1. Determine the Location of the PSE, Endpoint or Midspan.
2. Connect the PD simulator using alternative A
3. Attempt to power the PD simulator.
4. Switch Alternative and repeat steps 1-2.

Observable Results:

- The DUT must implement the correct pinout given its location on the link segment.

Possible Problems: None

33.1.2: Detection Circuit

Purpose: To verify the Thevenin equivalent detection circuit of the PSE detection source.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.5, Figures 33-8, 33-9

Resource Requirements:

- 45k Ω test load
- Current Source
- Current Meter
- Oscilloscope

Last Modification: September 23, 2003

Discussion: The PSE should detect the PD via the PSE PI. The PSE's detection circuit can have a Thevenin equivalent circuit consistent with Figure 33-8 or 33-9, in all detection states. This is intended to prevent a PSE to PSE connection from detecting a valid PD signature.

Test Setup: The PSE is connected to the PD simulator with a 1m length of Category 5 cable. A current source and current meter is connected to the PI of the PD simulator.

PSE Detection Source (Figure 33-8): The PSE is connected to the PD simulator with a 1m length of Category 5 cable. An oscilloscope is connected across the PI of the PD simulator. A 45k Ω load is attached to the PD's PI.

Alternative PSE Detection Source (Figure 33-9): The PSE is connected to the PD simulator with a 1m length of Category 5 cable. A current meter is connected to the PI of the PD simulator. A current source is connected to the PI of the PD simulator to inject current to the $V_{\text{detect}+}$ port.

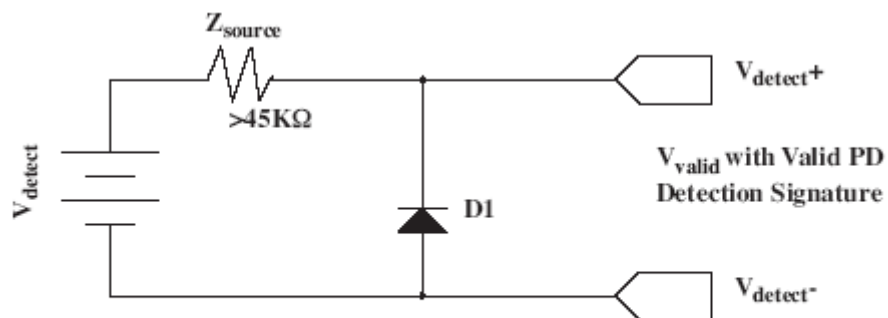


Figure 33-8—PSE detection source

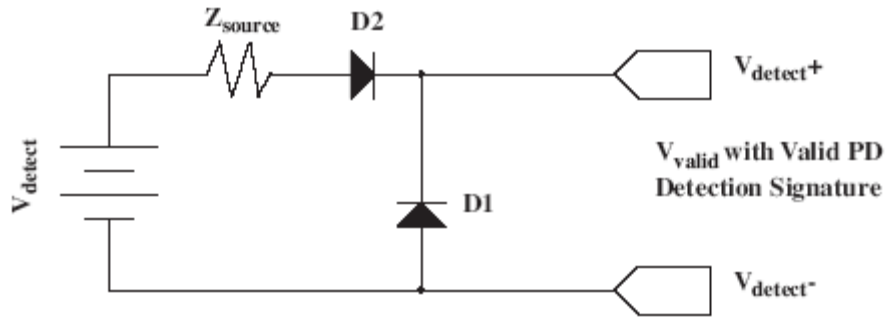


Figure 33-9—Alternative PSE detection source

Procedure:

1. Connect the current source to the PI
2. Measure the current flowing into the $V_{\text{detect}+}$ port of the PSE
3. If current was not accepted in step 2, measure the maximum output voltage of the open circuit PI. Otherwise, the test is complete.
4. Disconnect the current source
5. Connect the 45k Ω test load to the PI
6. Measure the maximum output voltage of the loaded PI

Observable Results:

- If the DUT does not accept current into the $V_{\text{detect}+}$ port, the DUT follows Figure 33-9. Otherwise, the DUT should accept current into the $V_{\text{detect}+}$ port and the DUT should show a loaded PI voltage of less than half of the open circuit PI voltage, according to Figure 33-8.

Possible Problems: None

33.1.3: Backdrive Current

Purpose: To verify the detection circuit of the PSE can withstand maximum backdrive current over the range of V_{Port} .

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.5, Table 33-5

Resource Requirements:

- PD Simulator
- Current Source

Last Modification: September 23, 2003

Discussion: The PSE must be able to handle a PSE to PSE connection. The standard specifies this as the DUT receiving a backdrive current of 5mA at a voltage corresponding to V_{Port} . After the maximum backdrive current has been applied, the DUT should still be capable of detecting an attached PD.

Test Setup: The PSE is connected to the PD simulator with a 1m length of Category 5 cable. A current meter is connected to the PI of the PD simulator.

Procedure:

1. Using the 5mA source, inject a current into the PSEs $V_{detect+}$ port for 10 seconds.
2. Disconnect the current source from the PSE and attach a valid PD signature
3. Observe if the PSE correctly detects the PD and supplies power
4. Disconnect the valid PD
5. Re-connect the current source and inject current into the PSEs $V_{detect-}$.
6. Disconnect the current source
7. Re-connect the PSE to a valid PD
8. Observe if the PSE correctly detects the PD and supplies power

Observable Results:

- The DUT should not be affected by the backdrive current.

Possible Problems: None.

33.1.4: Open Circuit Voltage

Purpose: To verify that the open circuit voltage at the PI of the PSE during detection mode is below the conformance limit.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.5 and Table 33-2.

Resource Requirements:

- Oscilloscope

Last Modification: September 22, 2003

Discussion: The PSE should detect that a valid PD has been connected. During the detection mode, the open circuit voltage (V_{oc}) of the PSE should not exceed 30V.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Measure the open circuit voltage at the PI of the DUT using a high impedance probe.

Observable Results:

- The open circuit voltage (V_{oc}) should not exceed 30 Volts.

Possible Problems: None

33.1.5: Detector Circuit Output Current

Purpose: To verify that the short circuit output current of the PSE during PD detection is within the conformance limits.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.5, Table 33-2

Resource Requirements:

- PD Simulator
- Oscilloscope
- Current meter

Last Modification: September 23, 2003

Discussion: The PSE should limit its output current during detection such that in the event of a short circuit condition, the PSE will not be damaged. The output current for the PSE detection circuit should not exceed 5mA. This value assures the PSE and any attached media will not be damaged.

Test Setup: The DUT is connected to the PD simulator, configured as a short circuit.

Procedure:

1. Using the current probe, measure the short circuit current at the PI.
2. Repeat step 1 for all probe voltages sourced by the DUT.

Observable Results:

- In step 1, the short circuit current should not exceed 5 mA.

Possible Problems: None

33.1.6: Detector Circuit Output Voltage

Purpose: To verify that the test voltages of the PSE detection circuit conform to the specifications defined in Table 33-2.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.5.1, Table 33-2

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: June 30, 2004

Discussion: While the PSE is probing the link segment for a valid PD detection signature, the detection voltage V_{detect} at the PSE PI should be within the V_{valid} voltage range of 2.8 to 10 Volts. The loaded circuit values are measured with a valid PD signature attached to the PSE. The PSE should make at least 2 measurements with V_{detect} values that create at least a ΔV_{test} difference of 1 Volt.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI. Confirm that the DUT is operating in PD detection mode and transmitting probe voltages.

Procedure:

1. Supply a valid signature using the PD simulator board at the PI of the DUT
2. Measure the probe voltages at the PI of the DUT.
3. Measure the slew rate of the probe voltages.

Observable Results:

- In step 2, the loaded PI output detection voltages should be between 2.8 and 10 volts.
- b. In step 2, the voltage difference between consecutive detection probe voltages should be at least 1 volt.
- In step 3, the slew rate of the probe voltages should be less than 0.1 V/ μ s

Possible Problems: None

33.1.7: PD Detection Timing

Purpose: To verify that the PSE probes its PI with valid detection pulses and completes an entire detection sequence within the proper time period.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.5, Table 33-2, Table 33-5.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: While the PSE is probing the link segment for a valid PD detection signature, the PSE is required to make at least 2 measurements within V_{detect} values. During these measurements, the time between any two valid test points must be at least 2ms (T_{BP}), while the total time taken for the PSE to complete detection should not be greater than 500ms (T_{det}).

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI. Confirm that the DUT is in PD detection mode and transmitting probe voltages.

Procedure:

1. Measure the pulse width of the entire detection sequence.
2. Measure the time between any two valid detection voltages.

Observable Results:

- In step 1, the total pulse width of the detection pulse should not be greater than 500ms.
- In step 2, the time between any two valid detection pulses should be at least 2 ms.

Possible Problems: None

33.1.8: PD Signature Detection Limits

Purpose: To verify that the DUT will properly detect a PD's signature impedance.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.6.1; Table 33-2

Resource Requirements:

- PD Simulator
- Voltmeter

Last Modification: September 23, 2003

Discussion: The PSE should be able to detect the signature impedance of an attached PD. This detection is accomplished by probing the PD via the PI. From this signature, the PSE should determine whether or not to supply power to the attached PD. The PSE should only provide power if the PD presents a signature which is compliant with Table 33-2 which is partially printed here for convenience.

Item	Parameter	Minimum	Maximum
7	R _{good} (KΩ)	19	26.5
8	R _{bad} (KΩ)	15	33
10	C _{good} (nF)		150
11	C _{bad} (μF)	10	

Table 33-2

Test Setup: The DUT is connected to the PD Simulator with a 1m length of Category 5 cable.

Procedure:

Part a: Input Resistance Minimums

1. Adjust the PD simulator to have a valid input signature capacitance (0.1μF)
2. Increase the signature resistance from R_{bad}min until the DUT supplies power to the PD
3. Record the value at which the PSE accepts the PD signature resistance.
4. Decrease the signature resistance below R_{good}min until the DUT does not supply power to the PD
5. Record the value at which the PSE rejects the PD signature resistance.

Part b: Input Resistance Maximums

6. Increase the signature resistance above R_{good}max until the DUT does not supply power to the PD
7. Record the value at which the PSE rejects the PD signature resistance.
8. Decrease the signature resistance from R_{bad}max until the DUT supplies power to the PD.

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9. Record the value at which the PSE accepts the PD signature resistance.

Part c: Input Capacitance “Must Accept”

10. Set the PD signature model to have a resistance between R_{goodmin} and R_{goodmax} (22k Ω).
11. Set the PD signature model to have a capacitance of C_{sigmax} less than 150nF
12. Connect the PD signature model to the PI of the DUT and observe the voltage at the PI.

Part d: Input Capacitance “Must Reject”

13. Set the PD signature model to have a capacitance of greater than C_{badmin} (10 μF)
14. Connect the PD signature model to the PI of the DUT and observe the voltage at the PI.

Observable Results:

- In step 3 and 5, the resistance ($R_{\text{accept(min)}}$) should be between 15k Ω and 19k Ω
- In step 7 and 9, the resistance ($R_{\text{accept(max)}}$) should be between 26.5k Ω and 33k Ω
- In step 12, the DUT should accept the PD signature and may provide power
- In step 14, the DUT should reject the PD signature and not provide power

Possible Problems: None.

33.1.9: PD Classification

Purpose: To verify a PSE supporting classification properly performs PD class detection.

Reference:

[1] IEEE Std 802.3-2005: Subclause 33.2.7, Table 33-3, Table 33-4.

Resource Requirements:

- PD simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: The PSE may attempt to classify the PD. Also, the PD may provide information to allow features such as load management to be implemented. The PSE should probe the PD with a voltage between 15.5 and 20.5 volts limited to 100 mA. The PSE should measure I_{Class} and classify the PD based on the observed current as dictated by Table 33-4, which is printed here for convenience.

Measure I_{class}	Classification
0mA to 5mA	Class 0
>5mA and <8mA	May be Class 0 or 1
8mA to 13mA	Class 1
>13mA and <16mA	May be Class 0, 1 or 2
16mA to 21mA	Class 2
>21mA and <25mA	May be Class 0, 2 or 3
25mA to 31mA	Class 3
>31mA and <35mA	May be Class 0, 3 or 4
35mA to 45mA	Class 4
>45mA and <51mA	May be Class 0 or 4

Table 33-4

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Set the load resistance to the minimum.
2. Measure V_{Class} using an oscilloscope before 75 ms (T_{pdc}).
3. Measure the I_{Class} .
4. Vary the resistance stepwise to draw the different levels of current.
5. After the classification time (T_{pdc}), measure the voltage (V_{Port}) across the PD model.

Observable Results:

- In step 2, the DUT should supply voltage between 15.5-20.5 Volts.

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- In step 3, the DUT should accurately classify the PD.
- In step 3, if the I_{class} is greater than or equal to 51mA the DUT should classify the PD as Class 0.
- In step 4, the DUT should supply current less than 100 mA.

Possible Problems: If the DUT does not perform classification, then the DUT should assign the PD to Class 0.

33.1.10: Classification Timing

Purpose: To verify that a PSE capable of classifying a PD completes the classification within T_{PDC} after successfully completing the detection of a PD.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8, Table 33-5

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: After successful detection of a PD, a PSE supporting classification must complete classification within the time frame of 10 to 75ms (T_{pdC}). The classification should occur anytime within the time frame of 400 ms (T_{pon}). If the PSE fails to power the PD within T_{pon} , it must reinitiate the detection and optional classification sequence.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Measure the width of the classification. Classification width is the time that the DUT initiates classification to the time that it has completed one classification cycle.

Observable Results:

- In step 1, the width of the class pulse should be between 10 and 75ms.

Possible Problems: This test does not apply to a DUT that does not perform PD classification.

33.1.11: New Detection Cycle

Purpose: To verify that if the PSE is unable to supply power within T_{pon} then, it initiates and successfully completes a new detection cycle before powering on.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.3.1, Table 33-5.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: The PSE may apply power after a valid sequence of detection and optional classification. However if the PSE is unable to supply power within a time interval of 400ms (t_{pon_timer}), then it must initiate a new valid detection cycle before applying power. The ‘ t_{pon_timer} ’ timer is used to limit the time for power turn-on, which is referred to as T_{pon} in Table 33-5.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Supply a valid signature at the DUT’s PI for a time approximately lesser than the T_{pon} of the DUT. (Refer to Test # 33.1.7 for the value of turn on time for the DUT.)
2. Connect an invalid signature at the DUT’s PI for at least 2sec.
3. Reconnect the valid signature at the DUT’s PI.
4. Observe the waveform on the oscilloscope.
5. Measure the detection time.
6. Measure the T_{pon} .

Observable Results:

- The DUT should complete a full detection cycle before applying power to the PD simulator.

Possible Problems: None

33.1.12: Alternative A Backoff Cycle

Purpose: To verify that if a PSE that implements Alternative A detects an invalid signature at its PI, it will resume detection in times less than one second.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.3.1.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: December 21, 2005

Discussion: When a PSE implementing Alternative A detects an invalid signature, it should initiate a second detection attempt within 1 second after beginning the first detection attempt. This ensures that Alternative A devices will not interfere with Alternative B devices if on the same link segment.

Test Setup: The PSE is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Connect an invalid signature at the DUT's PI.
2. Measure the time between consecutive detection sequences.

Observable Results:

- In step 2, the time between consecutive detection sequences must be less than 1 second.

Possible Problems: This test does not apply to a PSE that implements Alternative B.

33.1.13: Alternative B Backoff Cycle

Purpose: To verify that if a PSE that implements Alternative B fails to detect a valid detection signature at its PI, it will back off for no less than T_{dbo} and apply a voltage less than 2.8VDC during the backoff.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.3.1, Table 33-5.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: A PSE that implements Alternative B will start the 'tdbo_timer' if it fails to detect a valid signature at its PI. The 'tdbo_timer' is used to regulate backoff upon detection of an invalid signature as is referred to as T_{dbo} in Table 33-5. During this backoff period, the PSE must not apply a voltage greater than 2.8Vdc to the PI. A PSE that implements Alternative B detection must not resume detection mode until at least one backoff cycle has elapsed.

Test Setup: The PSE is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Connect an invalid signature at the DUT's PI.
2. Measure the DC voltage between the consecutive valid detection sequences.
3. Measure the time between consecutive valid detection sequences.

Observable Results:

- In step 2, the DUT must not apply a voltage greater than 2.8 Vdc at its PI.
- In step 3, $T_{dbo} > 2$ sec.

Possible Problems: This test does not apply to a PSE that implements Alternative A.

Group 2: Power Feed Characteristics

Scope: This group of tests verifies the electrical and functional characteristics during of the Power Sourcing Equipment while feeding power.

Overview: These tests are designed to identify problems with IEEE802.3-2005 Clause 33 compliant devices. Specifically, the problems related to the functional and electrical characteristics of Power Sourcing Equipment.

33.2.1: Turn On Rise Time

Purpose: To verify that when the PSE applies power, the response times of the PSE are within the conformance limits.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8, Table 33-5.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 26, 2003

Discussion: The PSE may turn on power when it detects a valid signature at its PI. Signal rise is defined as a transition from the baseline voltage to V_{Port} . This signal rise time (T_{Rise}) is defined to be the time difference between the point where the signal transition crosses 10% and 90% of V_{Port} of the PSE. All measured rise times should be greater than 15 μs as specified in Table 33-5. This implies that the slew rate during powering on should not exceed 3.04V/ μs .

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Provide a valid signature at the PI of the PSE.
2. Confirm that the PSE probes the link section with valid detection pulses before it powers on.
3. Measure the V_{Port} .
4. Measure the slew rate when the DUT is powering on the PD simulator.

Observable Results:

- In step 4, all measured slew rates should not exceed 3.04V/ μs .

Possible Problems: None

33.2.2: Power Feed Ripple and Noise

Purpose: To verify the power feeding ripple and noise are within the conformance limits.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8.3, Table 33-5

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: The PSE should source power at all rated levels with noise and ripple that are below the levels specified in item 3 of Table 33-5 (printed here for convenience). Excessive noise may cause attached PDs to behave abnormally.

Item	Parameter	Min	Max
3	Power feeding Ripple and noise (Vpp)		
	$f < 500\text{Hz}$		0.5
	$500\text{Hz} \leq f < 150\text{KHz}$		0.2
	$150\text{KHz} \leq f < 500\text{KHz}$		0.15
	$500\text{KHz} \leq f < 1\text{ MHz}$		0.1

Table 33-5

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Adjust the PD to sink .44 watts.
2. Measure the amount of pair-to-pair ripple and noise voltage at the PI of the PSE.
3. Measure the amount of common-mode ripple and noise voltage at the PI of the PSE.
4. Adjust the PD to sink 15.4 watts.
5. Repeat steps 3 and 4.

Observable Results:

- The ripple and noise peak-to-peak voltages, pair-to-pair and common-mode, in the band 0-500Hz will be less than .5 volts
- The ripple and noise peak-to-peak voltages, pair-to-pair and common-mode, in the band 500Hz-150kHz will be less than .2 volts
- The ripple and noise peak-to-peak voltages, pair-to-pair and common-mode, in the band 150kHz-500kHz will be less than .15 volts
- The ripple and noise peak-to-peak voltages, pair-to-pair and common-mode, in the band 500kHz-1MHz will be less than .1 volts

33.2.3: Load Regulation

Purpose: To verify that the PSE performs load regulation while supplying power on its PI.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8.2, Table 33-5

Resource Requirements:

- PD Simulator
- Multimeter

Last Modification: September 23, 2003

Discussion: The PSE should perform voltage regulation while supplying power to a PD over the PI. The output voltage of the PSE must stay between 44 and 57 volts if the load changes at a maximum rate of 35mA/ μ s. The PSE must not produce any transients greater than 3.5V/ μ s. These requirements prevent the voltage supply from exceeding the operating range of a PD.

Test Setup: Connect the DUT to the PD Simulator with a 1m length of Category 5 cable. Connect the multimeter to the PI of the PD simulator to measure voltage and current.

Procedure:

1. Connect the PSE to the PD simulator with a valid signature and the load set to draw 10mA.
2. Adjust the current draw of the PD from 10mA to 350mA in less than 9.7 μ s.
3. Observe the voltage transients and output voltage of the PSE at the PI.

Observable Results:

- In Step 3, the voltage transients seen should not exceed 3.5V/ μ s.
- In Step 3, the DUT output voltage at the PI should be within the range of 44 to 57 volts.

Possible Problems: None.

33.2.4: Power Turn On Timing

Purpose: To verify that the PSE starts applying power within T_{pon} after it has successfully detected the PD.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8.13, Table 33-5

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: The PSE must power on the PD after detection and optional classification within T_{pon} . If the PSE supports classification then it must successfully complete classification within the time frame of 10 to 75ms (T_{pdc}). If the PSE fails to power the PD within 400ms (T_{pon}), it must reinitiate the detection and optional classification sequence.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Confirm that the detection of the PD has been successfully completed.
2. Measure the time delay between the end of detection and when the PSE starts applying power.

Observable results:

- In step 2, the time delay (T_{pon}) should not be greater than 400ms.

Possible Problems: None.

33.2.5: Apply Power

Purpose: To verify that the PSE applies power on the same pairs as those used for detection after completing a valid detection.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.4, 33.2.5.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: A PSE detects the PD by probing it via the PSE's PI. A PSE should apply power only after it has completed the detection of a PD. The power should be supplied on the same pairs as those used for detection.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Supply a valid signature at the DUT's PI for a time approximately equal to T_{det} of the DUT.
2. Confirm that the DUT performs valid detection sequence before powering the PD simulator.
3. Check the pairs on which DUT supplies power.

Observable Results:

- In step 3, the DUT must power the PD simulator only after a proper detection sequence.
- In step 4, the DUT should supply power on the same pairs as that it performed detection for the PD simulator.

Possible Problems: None

33.2.6: Current Unbalance

Purpose: To verify that the current unbalance between the two conductors of the power pairs of the PSE over the current load range is within the permissible range.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8.12, Table 33-5.

Resource Requirements:

- PD Simulator
- Oscilloscope
- Multimeter

Last Modification: June 30, 2004

Discussion: A PSE supplies power via its PI to the PD using either Alternative A or Alternative B pinout. Ideally the current flowing on both the conductors per power pair should be the same, however due to practical limitations this is not possible. Thus, the current output unbalance between the two conductors per power pair should not exceed 3% of the I_{Port} of the PSE.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. Attach a current probe to each wire of the TX pair and allow the DUT to power the PD simulator.

Procedure:

1. Verify that the DUT is supplying power to the PD simulator.
2. Connect a resistive load to the DUT.
3. Set the PD simulator to draw at least 10mA.
4. Measure the current on both the twisted pairs at the PI of the DUT.
5. Vary the load so that the PD simulator draws the maximum current that the DUT can supply (at least 350mA).
6. Measure the current on both conductors per power pairs at the PI of the DUT.

Observable Results:

- In step 4 and step 6, the current unbalance between the two conductors per power pair should not be greater than 10mA.

Possible Problems: None

Group 3: Error Detection and Power Removal

Scope: This group of tests verifies the electrical and functional characteristics during error detection and power removal.

Overview: These tests are designed to identify problems with IEEE802.3-2005 Clause 33 compliant devices. Specifically, the problems related to the functional and electrical characteristics of Power Sourcing Equipment.

33.3.1: Overload Current Detection Range

Purpose: To verify that the PSE removes power if the I_{Port} exceeds the specified limits.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8.6, 33.2.8.7, Table 33-5, Figure 33C.6

Resource Requirements:

- PD Simulator
- Oscilloscope
- Current probe

Last Modification: September 9, 2004

Discussion: The PSE monitors the current (I_{Port}) drawn by the PD. If I_{Port} exceeds the overload current detection range I_{CUT} ($P_{class} / 44V$ to 400mA) for greater than 75ms (T_{Ovld}), the PSE should remove power from its PI. If the PSE does not implement classification then I_{CUT} should lie within the range of $(15.4/V_{Port})$ to 400mA. Figure 33C.6 that depicts the relationships between overload detection and timing is printed here for convenience.

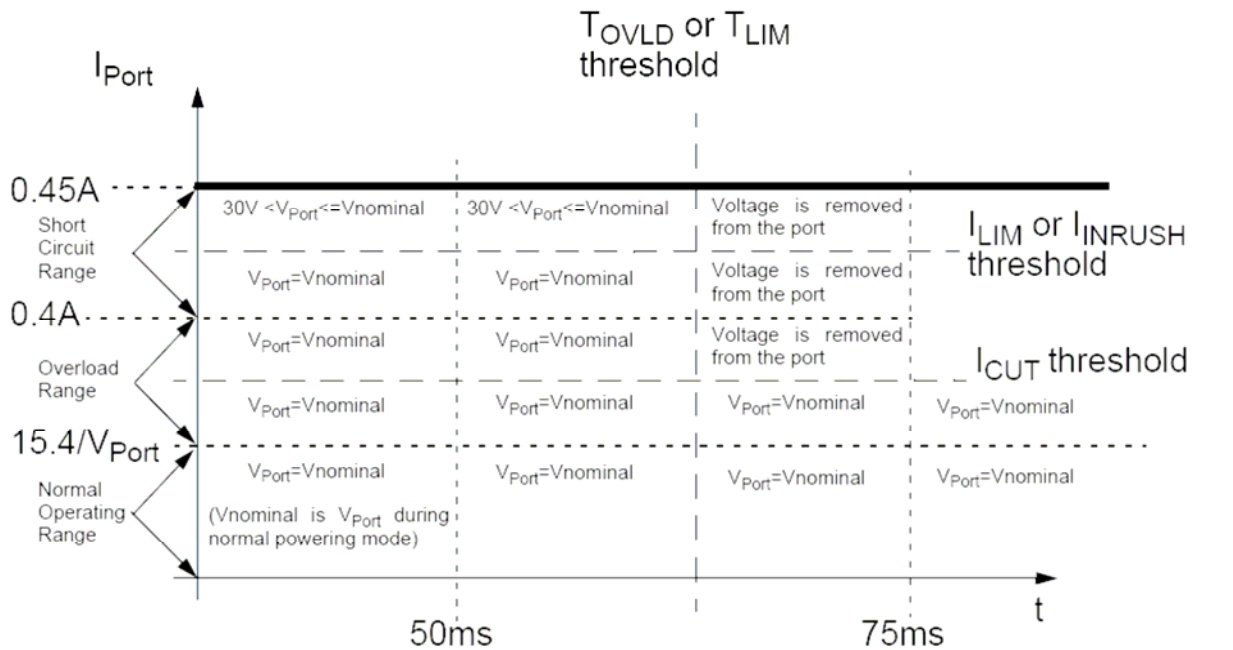


Figure 33C.6

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the current probe. The current probe is connected to the PD simulator at the PI.

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Procedure:

1. Verify that the PD is drawing current greater than or equal to I_{Min} from the DUT.
2. Measure the V_{Port} at the PI of the PSE.
3. If $44V \leq V_{Port} \leq 57V$ then connect the load to the DUT.
4. Decrease the load resistance gradually until the DUT removes power from its PI.
5. Measure the current (I_{CUT}) at which the DUT stops supplying power

Observable Results:

- In step 5, if the DUT supports classification, the value of I_{CUT} should lie between $P_{class}/44$ to 400mA; otherwise I_{CUT} should be between $15.4/V_{port}$ and 400mA(inclusive).

Possible Problems: None

33.3.2: Overload Time Limit

Purpose: To verify that the PSE removes power if I_{PORT} exceeds 400mA for a time greater than the overload time interval.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8.6, 33.2.8.7, Table 33-5, Figure 33C.6

Resource Requirements:

- PD Simulator
- Oscilloscope
- Current probe

Last Modification: September 23, 2003

Discussion: The PSE monitors the current (I_{Port}) drawn by the PD. If I_{Port} exceeds the overload current detection range I_{CUT} ($P_{class} / 44V$ to 400mA) for greater than 75ms (T_{Ovld}), the PSE should remove power from its PI. If the PSE does not implement classification then I_{CUT} should lie within the range of $(15.4/V_{Port})$ to 400mA. Figure 33C.6 that depicts the relationships between overload detection and timing. It is printed here for convenience.

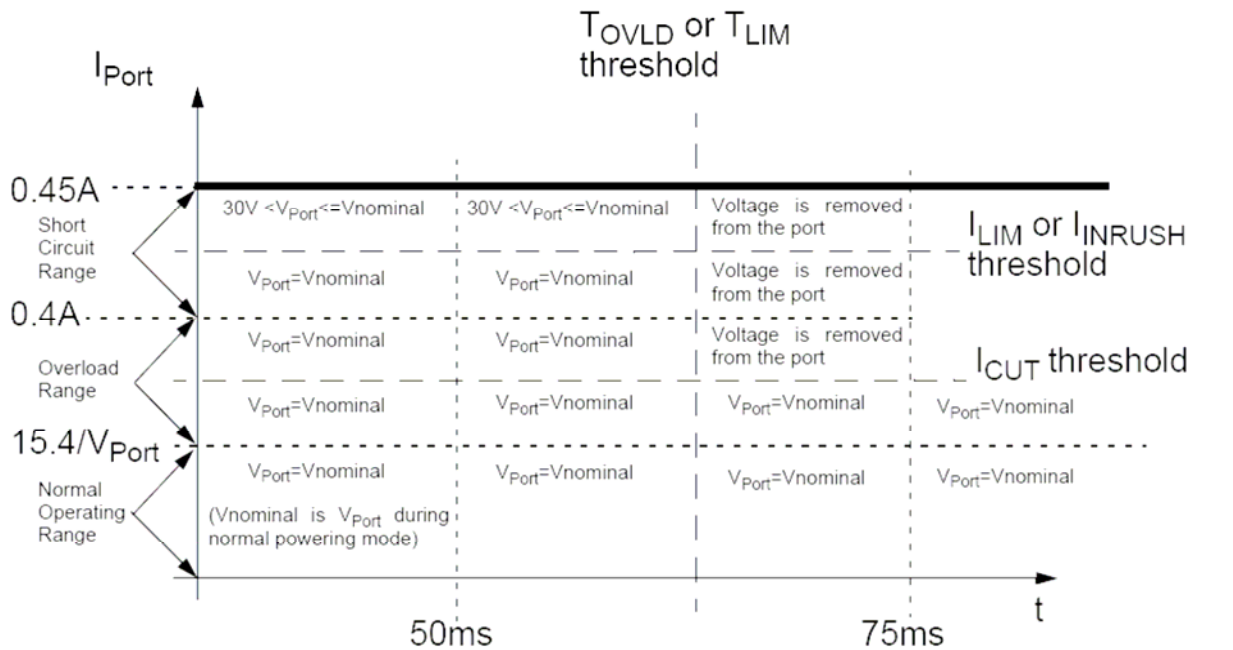


Table 33C.6

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

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Procedure:

1. Connect the PD to the DUT with the load set to maximum.
2. Vary the load until the $I_{Port} \geq I_{CUT}$.
3. Disconnect the load
4. Set the trigger on the PD simulator to connect the load to the DUT for a period of 50ms.
5. Increase the time in steps of 5 ms till 75ms.
6. Measure the current at which the DUT stops supplying power.
7. Record the time interval when the DUT removes power.

Observable Results:

- In step 7, the time interval (T_{ovld}) should be between 50ms and 75ms(inclusive).

Possible Problems: None

33.3.3: Inrush Current

Purpose: To verify that the inrush current during startup conforms to the specified values. Also, to ensure the PSE removes power within the conformant time limit when it detects a short circuit condition.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8.5, Table 33-5, Figure 33C.6, 33C.4, Annex 33C1.4

Resource Requirements:

- PD Simulator
- Oscilloscope
- Current probe

Last Modification: September 23, 2003

Discussion: The PSE monitors the current (I_{Port}) drawn by the PD. If the PD detects a short circuit condition, it must start removing power within 50 to 75ms (T_{LIM}) and must be done by 500ms (T_{Off}). The minimum inrush current applies for duration of T_{LIM} . During startup, for PI voltages greater than 30 V the inrush current must be between 400mA and 450mA. For PI voltages between 10V and 30V, the inrush current must be at least 60mA. Figure 33C.4, which defines the I_{Port} current, timing limits during startup and short-circuit conditions, is printed here for convenience. Figure 33C.6, which depicts the limits of the Inrush current and short circuit time limit, is also printed below.

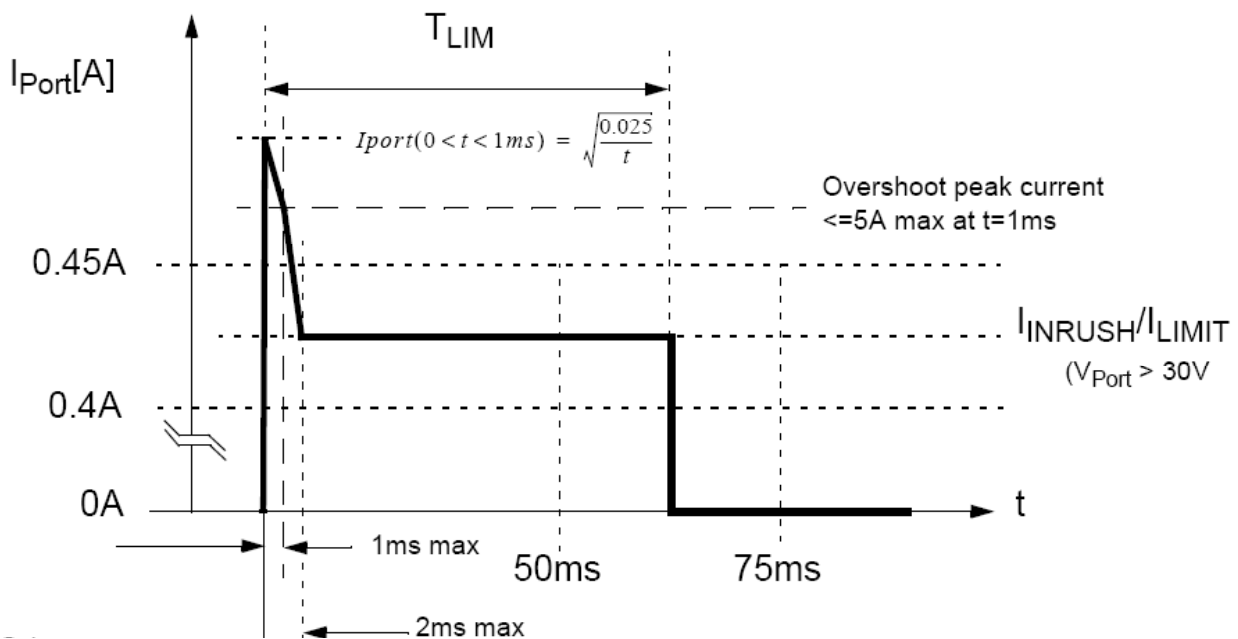


Figure 33C.4

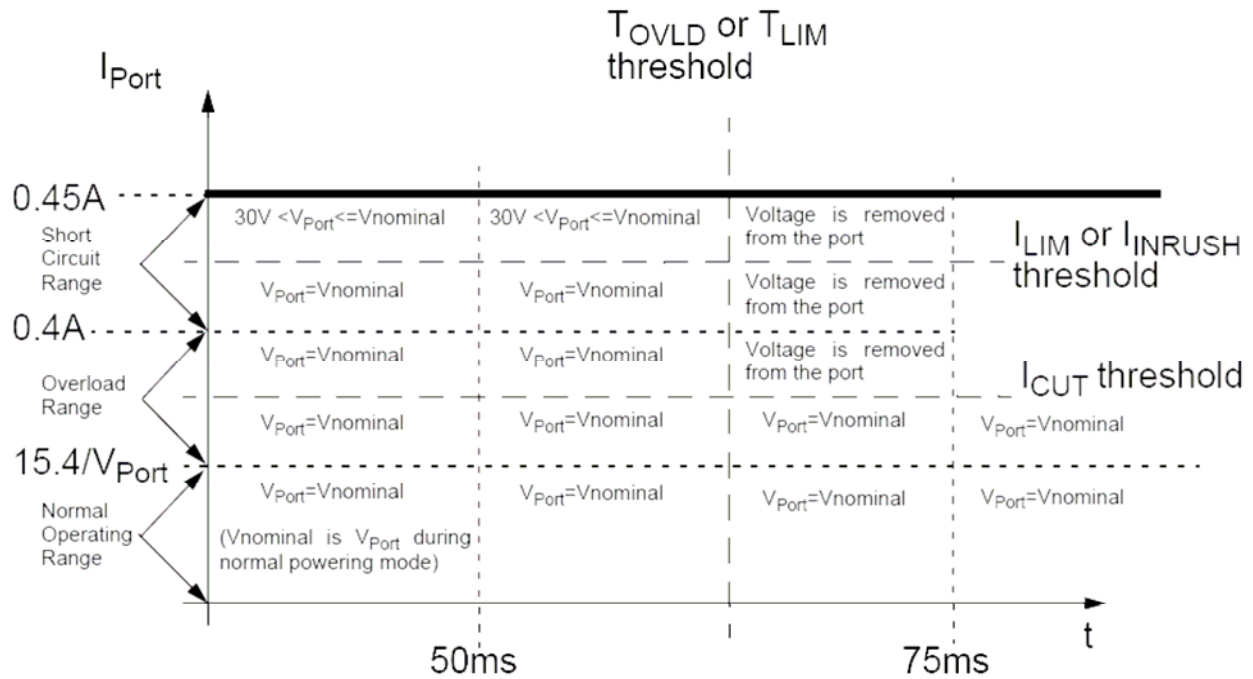


Figure 33C.6

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the current probe. The current probe is connected to the PD simulator at the PI.

Procedure:

1. Connect the 30 Volt Zener Diode using a fast switching circuit. This will establish a short circuit condition for more than 75ms.
2. Measure I_{Port} at the PI of the DUT.
3. Attach the 10 to 30 Volt short circuit simulator.
4. Measure I_{Port} at the PI of the DUT.

Observable Results:

- In step 2, the inrush current at the PI of the DUT must be between 400 to 450mA (inclusive).
- In step 4, verify that the inrush current at the PI of the DUT is at least 60mA.

Possible Problems: None

33.3.4: Short Circuit Time Limit

Purpose: To verify that the PSE starts removing power from the PI, within T_{LIM} , when it detects a short circuit condition.

References:

[2] IEEE Std 802.3-2005: Subclause 33.2.8.9, Table 33-5, Figure 33C.6, 33C.4, Annex 33C1.4

Resource Requirements:

- PD Simulator
- Oscilloscope
- Current probe

Last Modification: September 23, 2003

Discussion: The PSE monitors the current (I_{Port}) drawn by the PD. If the PD detects a short circuit condition, it must start removing power within 50 to 75ms (T_{LIM}). The minimum inrush current applies for a duration of T_{LIM} . Figure 33C.4 defines the I_{Port} current and timing limits during startup and short-circuit conditions. It is printed here for convenience. Figure 33C.6, which depicts the limits of the Inrush current and short circuit time limit, is also printed below.

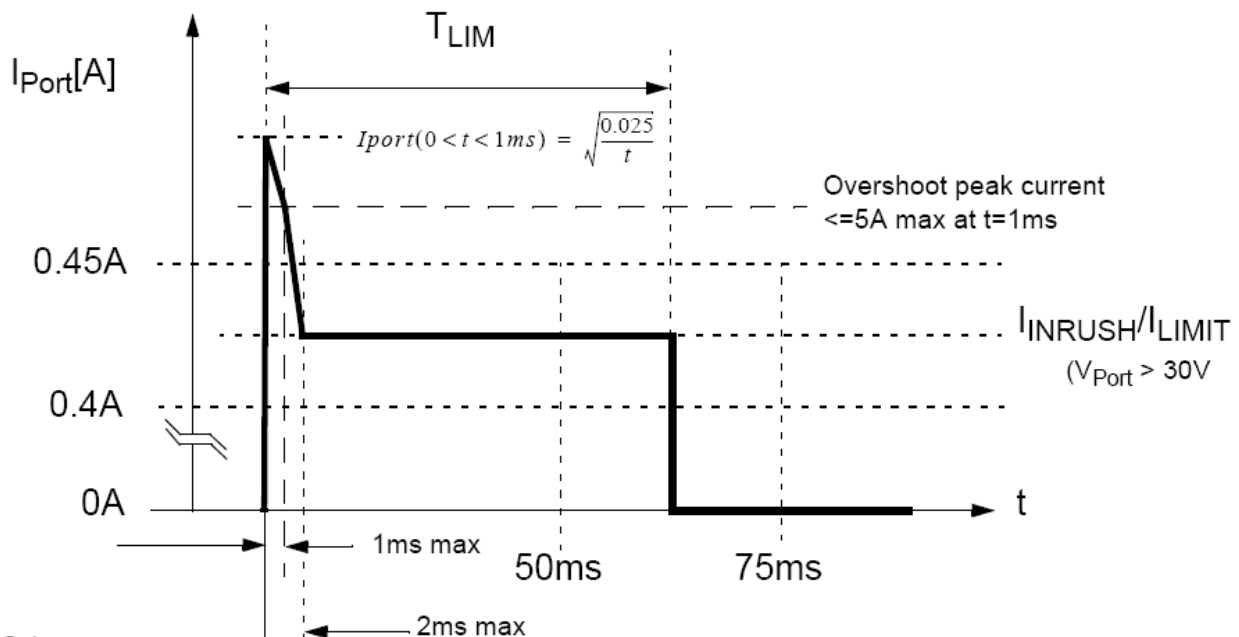


Figure 33C.4

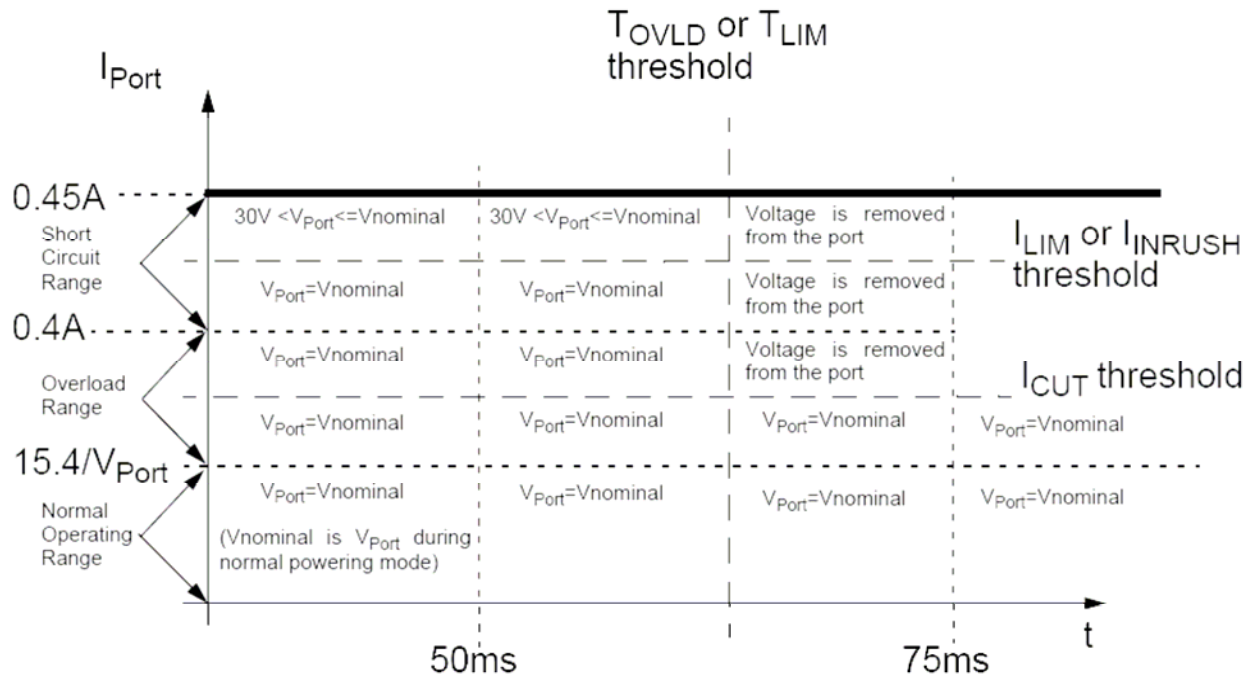


Figure 33C.6

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the current probe. The current probe is connected to the PD simulator at the PI.

Procedure:

1. Connect the large capacitive load using a fast switching circuit. This will emulate a short circuit condition for more than 75ms.
2. Measure V_{Port} at the PI of the DUT.

Observable Results:

- Verify that the DUT starts removing power within T_{LIM} .

Possible Problems: None.

33.3.5: Error Delay Timing

Purpose: To verify that the PSE waits for at least the minimum conformant time before attempting subsequent detection after it removes power due to the detection of the error condition.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.3.5, Table 33-5, Figure 33-6.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: If the PSE detects an error condition during its normal operation when the PSE is supplying power to the PD, it must remove power from its PI. The error condition can be a short circuit or an overload condition. The PSE must wait for at least 750ms (T_{ed}) before it commences with valid detection sequence after power removal.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

Part a: Short circuit condition

1. Verify that the DUT is supplying power to the PD simulator.
2. Create a short circuit condition at the PD simulator for at least 75ms.
3. Measure the time at which the DUT removes power from its PI.
4. Observe the time at which the DUT attempts subsequent detection.
5. Compute the difference between the time recorded in step 3 and 4.

Part b: Overload Condition:

6. Verify that the DUT is supplying power to the PD simulator.
7. Create an overload condition by increasing the current draw greater than 400mA for time greater than T_{ovld} .
8. Repeat steps 3 to 5.

Observable Results:

- In step 5, $T_{ed} \geq 750\text{ms}$.
- In step 8, $T_{ed} \geq 750\text{ms}$.

Possible Problems: None

33.3.6: Range of T_{MPDO} Timer

Purpose: To verify that the PSE correctly monitors the PD Maintain Power Signature.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.10.1.2, Table 33-5, Figure 33-6, Figure 33-7.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: Once a PSE has entered the 'POWER_ON' state, it must receive an 'mr_mps_valid' from the link partner within a specified amount of time. If this message is not received, it will enter the 'IDLE_MPS' state and remove power from the link segment before attempting a new detection sequence. This time is defined by the device's 'tmpdo_timer' and is required to be between 300ms and 400ms. This test is designed to verify that the device under test enters the 'IDLE_MPS' state from the 'POWER_ON' state when an mr_mps_valid message is not received from its link partner in the acceptable range of time.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

Part 1: DC disconnect

1. Attach a valid signature to the PI of the DUT such that the DUT enters the 'POWER_ON' state.
2. Reduce the current drawn by the PD to 2mA for $t \leq 300\text{ms}$.
3. Observe whether the DUT entered the 'IDLE_MPS' state.
4. Repeat steps 1-3 varying t until the DUT enters the 'IDLE_MPS' state.
5. Find the t for which the PSE removes power.

Part 2: AC disconnect

6. Attach a valid signature to the PI of the DUT such that the DUT enters the 'POWER_ON' state.
7. Disconnect the PD from the PI of the DUT.
8. Measure the time taken by the DUT to remove power.

Observable Results:

Part 1:

- In step 5, verify that $300\text{ms} \leq T_{\text{MPDO}} \leq 400\text{ms}$.

Part 2:

- In step 8, verify that $300\text{ms} \leq T_{\text{MPDO}} \leq 400\text{ms}$.

Possible Problems: None.

33.3.7: PD MPS Dropout Current Limits (I_{\min} measurement)

Purpose: To verify that the PSE correctly monitors the PD Maintain Power Signature.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.10.1.2, Table 33-5

Resource Requirements:

- PD Simulator
- Multimeter

Last Modification: September 23, 2003

Discussion: The PSE must monitor the link segment for the PD's Maintain Power Signature, and remove power if it detects that the PD is disconnected. The PSE may monitor the AC MPS component, the DC MPS component, or both signature components. If the PSE monitors the DC MPS component, the DUT should remove power from the PI if the current drawn by the PD drops below 5mA ($I_{\min1(\max)}$) for more than 400 ms (T_{MPDO}). The PSE may remove power if the current drawn by the PD is between 5mA and 10mA ($I_{\min2(\max)}$) for greater than 400ms (T_{MPDO}).

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The multimeter is connected to the PD simulator at the PI to measure current.

Procedure:

1. Set the PD Simulator to draw 10mA of current from the DUT
2. Decrease the current draw of the PD simulator from 10mA to less than 5mA for 400ms, in steps of 1mA.
3. Observe the output voltage at the PI of the DUT during each step.
4. Record the current draw at which the PSE removes power.

Observable Results:

- In Step 4, if the current drawn by the PD simulator is between 5mA and 10mA, the DUT may disconnect power from the PI.
- In Step 4, if the current drawn by the PD simulator is less than 5mA, the DUT must disconnect power from the PI.

Possible Problems: This test does not apply if the DUT performs only MPS AC disconnect.

33.3.8: PD MPS Time for Validity

Purpose: To verify that the PSE waits for at least the minimum MPS validity time when it monitors the DC MPS component.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.10, 3.2.10.1.2, Table 33-5, Figure 33-7

Resource Requirements:

- PD Simulator
- Oscilloscope
- Current probe

Last Modification: September 23, 2003

Discussion: The PSE can monitor either the DC or AC MPS component to verify if the PD is still drawing the minimum current (I_{MIN2}) that is required by the PSE. A PSE that monitors the DC MPS component of the signature will remove power from its PI if it detects that the PD is drawing current less than its I_{MIN1} (5mA) for greater than 400ms. In order to maintain a valid MPS signature, the PD can draw less than the I_{MIN1} (5mA) for 300ms and then draw more than its I_{MIN2} max (10mA) for the next 60ms or more. This improves the power efficiency of the PSE.

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the current probe. The current probe is connected to the PD simulator at the PI.

Procedure:

1. Verify that the DUT is supplying power to the PD simulator.
2. Confirm that the PD simulator is drawing more than 10 mA.
3. Set the PD simulator to draw less than 5 mA for 300ms.
4. Set the PD simulator to draw more than 10 mA for a period of 65ms and then drop the current back to less than 5 mA for the next 300ms.
5. Repeat step 3 and 4.
6. Measure the V_{Port} at the PI of the DUT.

Observable Results:

- $T_{MPS} \geq 60\mu s$

Possible Problems: If the DUT does not support DC MPS, then this test does not apply.

33.3.9: AC MPS Signal Parameters

Purpose: To verify that the PI AC probing signals fall within the conformance limits.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.10.1.1, Table 33-6, Figure 33C.15.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: Once power has been applied to the link section, the PSE must monitor the link segment for the PD’s Maintain Power Signature, and remove power if it detects that the PD has been disconnected. The PSE may monitor the AC MPS component, the DC MPS component, or both signature components. This test has been designed to verify that a PSE that monitors the AC MPS component meets the AC signal parameters as specified in Item 1 of Table 33-6, which has been printed here for convenience. These parameters can be measured as depicted in Figure 33C.15, which is also printed here for convenience.

Item	Parameter		Min	Max
	AC Signal Parameters			
1a	PI probing AC Voltage	V _{open} (Vpp)	1.9	10% of the average value of V _{Port} . (44V < V _{Port} < 60V)
		V _{open1} (Vp)		30V, V _{Port} ≤ 44V
1b	AC Probing Signal Frequency	Fp (Hz)		500
1c	AC Probing Signal Slew Rate	SR (V/μs)		0.1 (Positive or negative)

Table 33-6

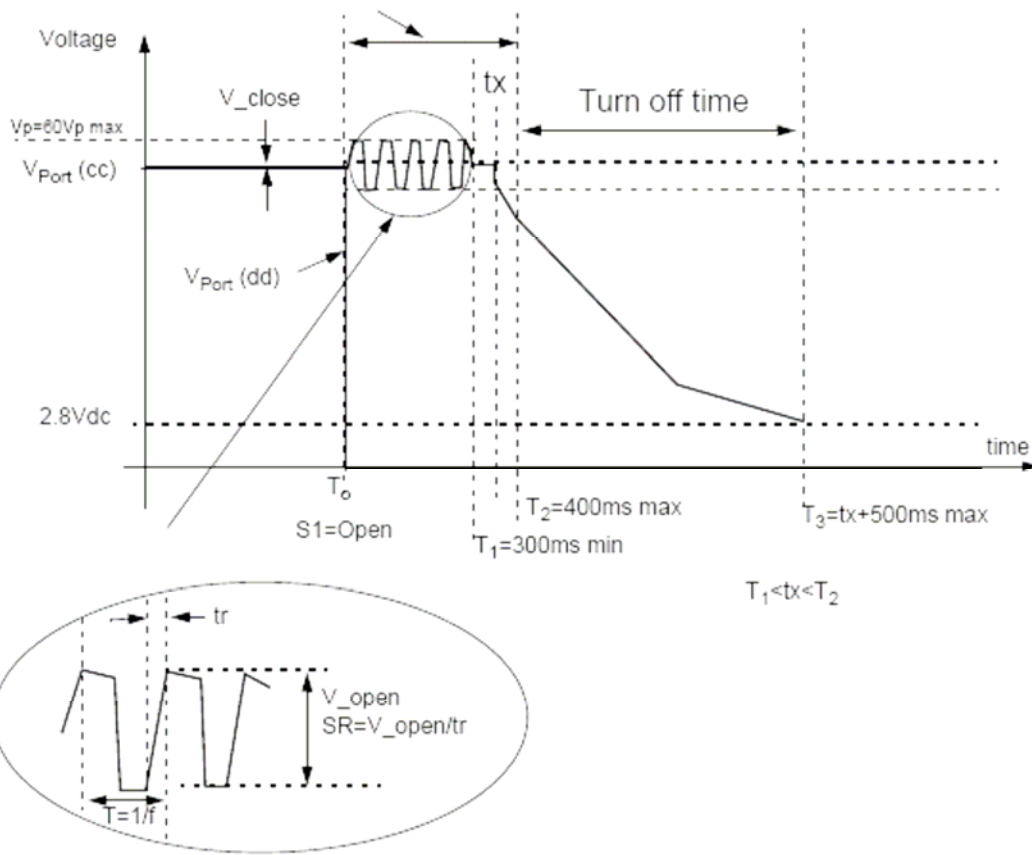


Figure 33C.15

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Attach a valid signature (less than or equal to $27K\Omega$) to the PI of the DUT.
2. Verify that the DUT is supplying power to the PD simulator.
3. Disconnect the signature from the PI of the DUT.
4. Verify that the DUT removes power from its PI within 400ms.
5. Measure the PI probing AC voltage (V_{open}).
6. Measure the PI probing signal frequency.
7. Compute the AC probing signal slew rate (SR).

Observable Results:

- $1.9V \leq V_{open} \leq 10\%$ of average value of V_{port} ($44V < V_{Port} < 57V$).
- The PI probing frequency should not be greater than 500Hz.
- The slew rate should not be greater than $0.1V/\mu s$.

Possible Problems: If the DUT does not support the AC MPS component, then this test does not apply.

33.3.10: AC Disconnect Detection Voltages

Purpose: To verify that the PI probing AC voltages during AC disconnect detection fall within the conformance limits.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.10.1.1, Table 33-6, Figure 33C.15.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: Once power has been applied to the link segment, the PSE must monitor this segment for the PD's Maintain Power Signature, and remove power if it detects that the PD has been disconnected. To perform this detection, the PSE may monitor the AC MPS component, the DC MPS component, or both signature components. This test is designed to verify that a PSE that monitors the AC MPS component meets the disconnect detection timing and PI voltages as specified in Item 3 of Table 33-6, which is printed here for convenience. These parameters can be measured as depicted in Figure 33C.15, which is also printed here for convenience.

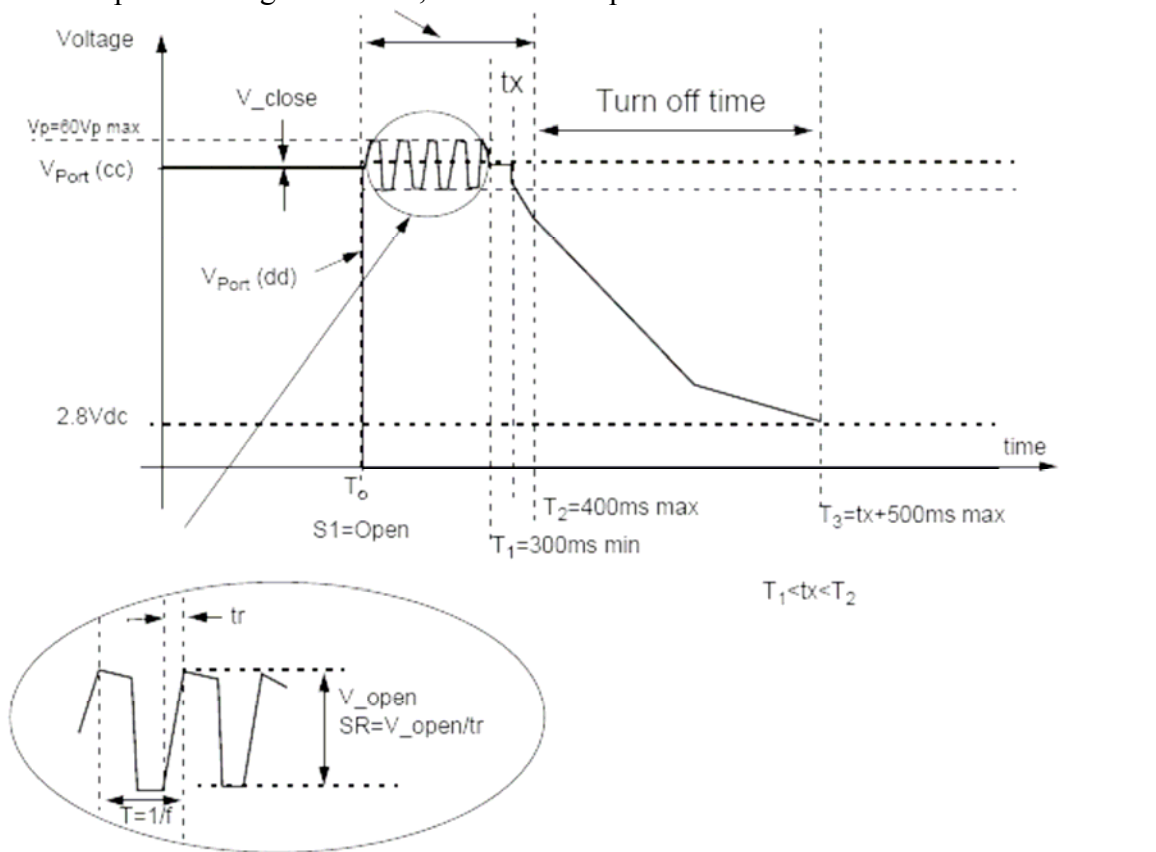


Figure 33C.15

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Item	Parameter		Min	Max
	AC Signal Parameters			
1a	PI probing AC Voltage	V _{open} (Vpp)	1.9	10% of the average value of V _{Port} . (44V<V _{Port} <57V)
		V _{open1} (Vp)		30V, V _{Port} ≤44V
1b	AC Probing Signal Frequency	Fp (Hz)		500
1c	AC Probing Signal Slew Rate	SR (V/μs)		0.1(Positive or negative)

Table 33-6

Test Setup: The DUT is connected to the PD Simulator with a 1m length of Category 5 cable.

Procedure:

1. Attach a valid signature (less than or equal to 27KΩ) to the PI of the DUT.
2. While the DUT is supplying power to the link section, measure the peak to peak ripple voltage.
3. Disconnect the signature.
4. Measure the peak voltage while the PD is disconnected.

Observable Results:

- In step 3, the AC ripple voltage should be less than 0.5Vpp.
- In step 5, the measured V_P should not exceed 60V.

Possible Problems: If the DUT does not support the AC MPS component, then this test does not apply.

33.3.11: AC MPS Signature

Purpose: To verify that the PSE that implements AC MPS component correctly monitors the PD Maintain Power Signature.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.10.1.1 and Table 33-5, Table 33-6, Figure 33-10, Figure 33-11.

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: September 23, 2003

Discussion: The PSE must monitor the link segment for the PD’s Maintain Power Signature, and remove power if it detects that the PD is disconnected. The PSE may monitor the AC MPS component, the DC MPS component, or both signature components. A PSE that monitors AC MPS component will remove power if it detects an AC impedance at the PI equal to or greater than 1980 K Ω ($|Z_{ac2}|$) as defined in Table 33-6, which is printed below for convenience. It may or may not remove power if it detects an AC impedance between 27K Ω ($|Z_{ac1}|$) and $|Z_{ac2}|$. The PSE will maintain power if it detects an impedance less than or equal to $|Z_{ac1}|$. The PSE will remove power from its PI if the AC MPS signature is absent for more than 400ms (T_{MPDO}).

Item	Parameter	Symbol	Unit	Min	Max	Additional information
AC Maintain Power Signature						
4a	Shall not remove power from the PI	$ Z_{ac1} $	K Ω		27	$F_p= 5\text{Hz}$, Testing voltage $>2.5\text{V}$. See Figure 33–10. Impedance shall have non-negative resistive component and a net capacitive reactive component.
4b	Shall remove power from the PI	$ Z_{ac2} $	K Ω	1980		See Figure 33–11.

Table 33-6

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Attach a valid signature (less than or equal to 27K Ω) to the PI of the DUT.
2. Confirm that the DUT is supplying power at its PI.
3. Increase the impedance connected to the PI of the DUT from 27K Ω to 2M Ω .

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4. Measure the V_{port} after 400msec.
5. If $44V \leq V_{port} \leq 60V$, repeat step 3.
6. Record the value of impedance (Z) at which the DUT removes power from its PI.

Observable Results:

- In Step 2, the DUT should supply power onto its PI.
- In Step 6, the impedance (Z) should be between $27K\Omega$ and $1980K\Omega$ (inclusive).

Possible Problems: If the DUT does not implement AC MPS disconnect, then this test does not apply.

33.3.12: Turn Off Time Limits

Purpose: To verify that the PSE disconnects power within T_{Off} through a test resistor.

References:

[1] IEEE Std 802.3-2005: Subclause 33.2.8.10, Table 33-5

Resource Requirements:

- PD Simulator
- Oscilloscope

Last Modification: July 14, 2004

Discussion: When the DUT is disconnected from a valid maintain power signature it shall remove power within T_{Off} through a test resistor of $320\text{k}\Omega$ attached to the PI. T_{Off} is defined as the discharge time from V_{Port} to 2.8Vdc .

Test Setup: The DUT is connected to the PD simulator with a 1m length of Category 5 cable. The oscilloscope is connected to the PD simulator at the PI.

Procedure:

1. Verify that the DUT is supplying power to the PD simulator.
2. Disconnect DUT with a $320\text{k}\Omega$ test resistor attached to the PI.
3. Measure the time at which the DUT removes power from its PI.

Observable Results:

- In step 3, $T_{\text{Off}} \leq 500\text{ms}$.

Possible Problems: For AC MPS the DUT can observe the test resistor as a valid MPS and will remain in powering mode.

Group 4: PSE Transmitter and Receiver Characteristics

Scope: This group of tests deals with conformance parameters specific to the transmitter and receiver of a PSE.

Overview: These tests are designed to identify problems with IEEE802.3-2005 Clause 33 compliant devices. Specifically, the problems related to the functional and electrical characteristics of Power Sourcing Equipment devices.

33.4.1: Midspan PSE Return Loss

Purpose: To verify that the return loss of a Midspan PSE is greater than the minimum conformant value.

References:

[1] IEEE Std 802.3-2005: Subclause 33.4.8.1.3, Table 33-14.

Resource Requirements:

- Vector Network Analyzer
- 125MHz Balun

Last Modification: June 16, 2006

Discussion: From the standard: “Return loss is a measure of the reflected signal energy caused by impedance mismatches in the cabling system and is expressed in dB relative to reflected signal level. Return loss shall be measured for Midspan PSE devices for the transmit and receive pairs from 1MHz to 100MHz and shall meet or exceed the values specified in table 33-14.” The Midspan PSE is an addition to the standard Ethernet link segment. It must not degrade the Ethernet signaling. The Midspan’s return loss must be sufficiently high to avoid this risk.

Frequency	Return Loss
$1 \text{ MHz} \leq f < 20\text{MHz}$	23dB
$20\text{MHz} \leq f < 100\text{MHz}$	14dB

Table 33-14 – Connector Return Loss

Test Setup:

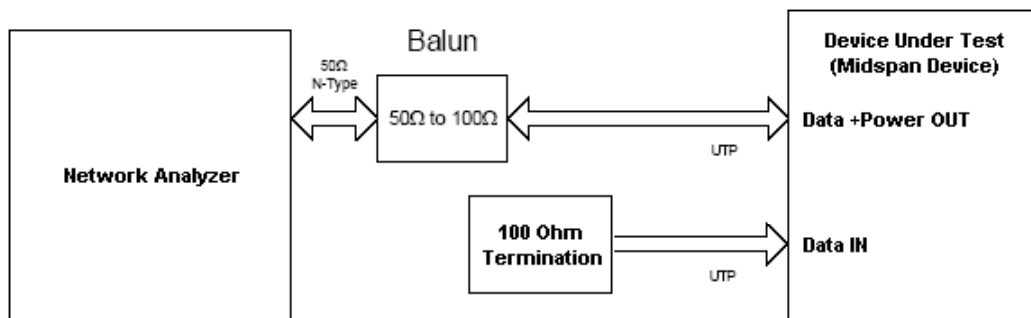


Figure 33.4.1 - Test Setup for Midspan Return Loss

Procedure:

1. Calibrate the VNA for a return loss measurement from 1-100MHz.
2. Connect the DUT to the VNA according to the setup shown in the figure 33.4.1
3. Over the frequency ranges specified in table 33-14, perform S_{11} measurements on the transmit pairs of the Midspan.
4. Repeat the measurements on the receive pairs.

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Observable Results:

- The DUT must exhibit the minimum return loss over the specified frequency range.

Possible Problems: None

33.4.2: Midspan PSE Insertion Loss

Purpose: To verify that the insertion loss of a Midspan PSE is less than the maximum conformant value.

References:

[1] IEEE Std 802.3-2005: Subclause 33.4.8.1.3, Table 33-14.

Resource Requirements:

- Vector Network Analyzer
- 125MHz Balun

Last Modification: July 5, 2006

Discussion: From the standard: “Insertion loss is a measure of the signal loss between the transmitter and receiver, expressed in dB relative to the received signal level. Insertion loss shall be measured for Midspan PSE devices for the transmit and receive pairs from 1 to 100MHz, and shall meet the values determined by Equation (33-6). However, for frequencies that correspond to calculated values less than 0.1 dB, the requirement reverts to the maximum requirement of 0.1 dB.” The Midspan PSE is an addition to the standard Ethernet link segment. It must not degrade the Ethernet signaling. The Midspan’s insertion loss must be sufficiently low to avoid this risk.

$$\text{Insertion_loss}_{\text{conn}} \leq 0.04 \text{ SQRT}(f) \text{ dB}$$

Equation 33-6

Test Setup:

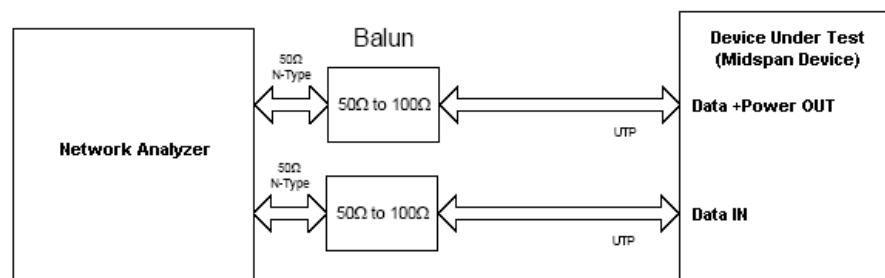


Figure 33.4.2 - Test Setup for Midspan Insertion Loss

Procedure:

1. Calibrate the VNA for a two port transmission measurement
2. Connect the DUT to the VNA according to the setup shown in figure 33.4.2
3. Perform S_{21} measurement from 1-100MHz on the transmit pairs of the Midspan.
4. Repeat the measurement on the receive pairs.

Observable Results:

- The DUT must exhibit the maximum insertion loss as described by equation 33-6 and the general requirement of 0.1dB.

33.4.3: Midspan PSE Near-End Cross-Talk (NEXT)

Purpose: To verify that the NEXT between the transmit and receive pairs of the DUT is within conformance limits.

References:

[1] IEEE Std 802.3TM-2005: Section 33.4.8.1.1

Resource Requirements:

- Vector Network Analyzer
- 125MHz Balun

Last Modification: July 5, 2006

Discussion: The standard states: “NEXT loss is a measure of the unwanted signal coupling from a transmitter at the near-end into neighboring pairs measured at the near-end. NEXT loss is expressed in dB relative to the received signal level. NEXT loss shall be measured for Midspan PSE devices for the transmit and receive pairs from 1MHz to 100MHz and shall meet the values determined by Equation (33–5). However, for frequencies that correspond to calculated values greater than 65 dB, the requirement reverts to the minimum requirement of 65 dB.

$$\text{NEXT conn} \geq 40 - 20\log(f/100) \text{ dB}$$

Equation 33-5

Test Setup:

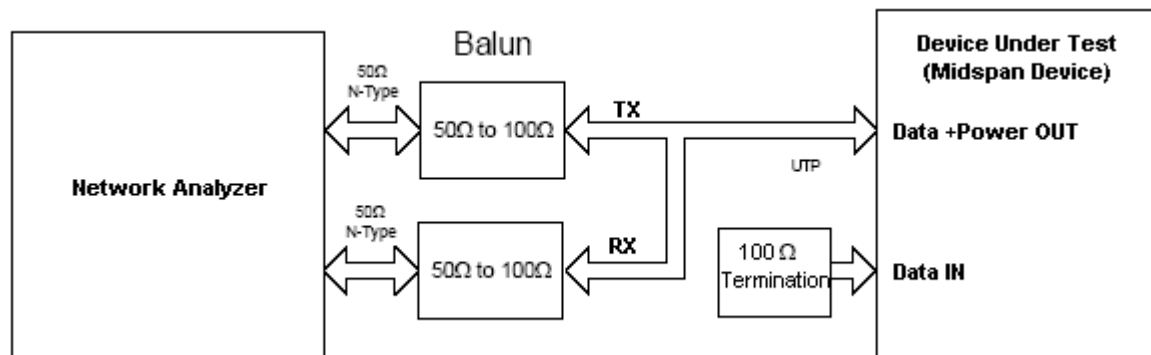


Figure 33.4.3 -Test Setup for Midspan NEXT

Procedure:

1. Setup DUT in test fixture as shown in figure 33.4.3
2. Perform transmission calibration on VNA
3. Measure NEXT for 1-100MHz.

Observable Results:

- The NEXT loss shall exceed the requirement enumerated by equation 33-5. When the requirement for NEXT loss is greater than 65 dB (as governed by equation 33-5), the requirement reverts to the 65 dB minimum.

33.4.4: PSE Impedance Balance

Purpose: To verify that the common-mode to differential-mode impedance balance of the transmit and receive pairs of the PI is greater than the specified limits.

References:

- [1] IEEE Std 802.3™-2005: Section 33.4.3
- [2] IEEE Std 802.3™-2005: Figure 33-14

Resource Requirements:

- Vector Network Analyzer
- Impedance Balance Test Circuit
- 125MHz Balun

Last Modification: July 5, 2006

Discussion: The standard defines impedance balance as a measurement of the common-mode-to-differential-mode offset of the PI. Impedance balance is further defined by the following equation:

$$20\log_{10}(E_{cm}/E_{dif})$$

Equation 33-4

E_{cm} is an externally applied AC voltage as shown in Figure 33–14 [shown below] and E_{dif} is the resulting waveform due only to the applied sine wave. The test circuit is reprinted for convenience below:

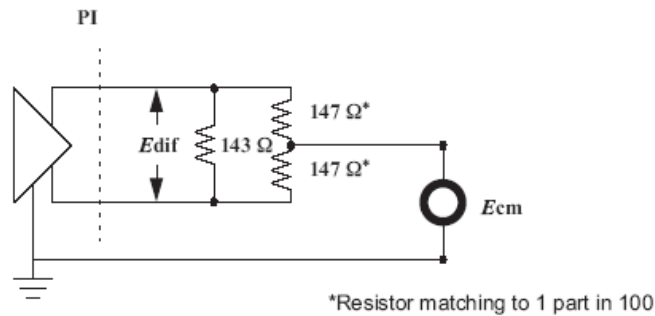


Figure 33–14—PI impedance balance test circuit

The impedance balance of the transmit and receive pairs shall meet or exceed the following minimum requirements:

10 Mb/s PHY	100 Mb/s or greater PHY
$29 - 17\log_{10}(f/10)$ dB	$34 - 19.2\log_{10}(f/50)$ dB
Equation 33-2	Equation 33-3

where f is the frequency in MHz.

Test Setup:

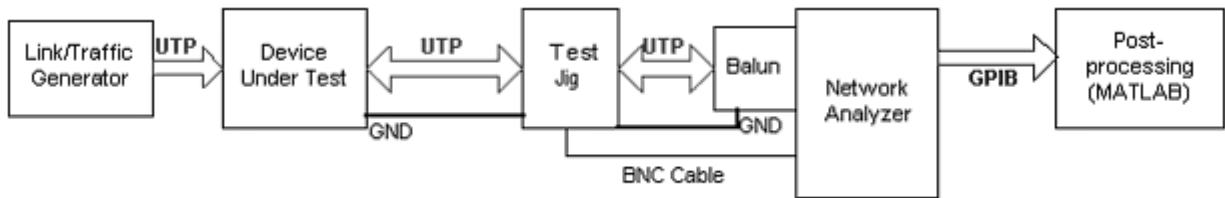


Figure 33.4.4 Impedance Balance Test Setup

Procedure:

1. Setup the DUT as shown in figure 33.4.4
2. Measure E_{dif} over the specified frequency range.
3. Compute the Impedance Balance.
4. Repeat the measurement with the receive pairs of the PSE.

Observable Results:

- The common-mode to differential-mode impedance balance of the transmit and receive pairs is defined as $20\log_{10}(E_{CM}/E_{D_OUT})$ where E_{cm} is an externally applied AC voltage and E_{D_OUT} is the resulting waveform due only to the applied sine wave. This can be seen in figure 33-16, reprinted above for convenience.
- The common-mode to differential-mode impedance balance for a 10Mb/s transmitter and receiver shall exceed $29-17\log_{10}(f/10)$ (where f is the frequency in MHz) over the frequency range of 1.0 MHz to 100 MHz
- The common-mode to differential-mode impedance balance for a 100Mb/s transmitter and receiver shall exceed $34-19.2\log_{10}(f/50)$ (where f is the frequency in MHz) over the frequency range of 1.0 MHz to 100 MHz

Possible Problems: None

33.4.5: PSE Common Mode Output Voltage

Purpose: To verify that the common mode AC output voltage at the PI is below the conformant limits.

References:

[1] IEEE Std 802.3TM-2005: Section 33.4.8.1.1

Resource Requirements:

- Vector Network Analyzer

Last Modification: July 5, 2006

Discussion: From the standard: “The magnitude of the common-mode AC output voltage measured according to Figure 33–15 and Figure 33–16 at the transmit PI while transmitting data and with power applied, E_{cm_out} , shall not exceed 50 mV peak when operating at 10 Mb/s, and 50 mV peak-to-peak when operating at 100 Mb/s or greater. The magnitude of the common-mode AC voltage shall not exceed 50mV peak-to-peak measured at all other PIs. The frequency of the measurement shall be from 1 MHz to 100 MHz.”

Test Setup:

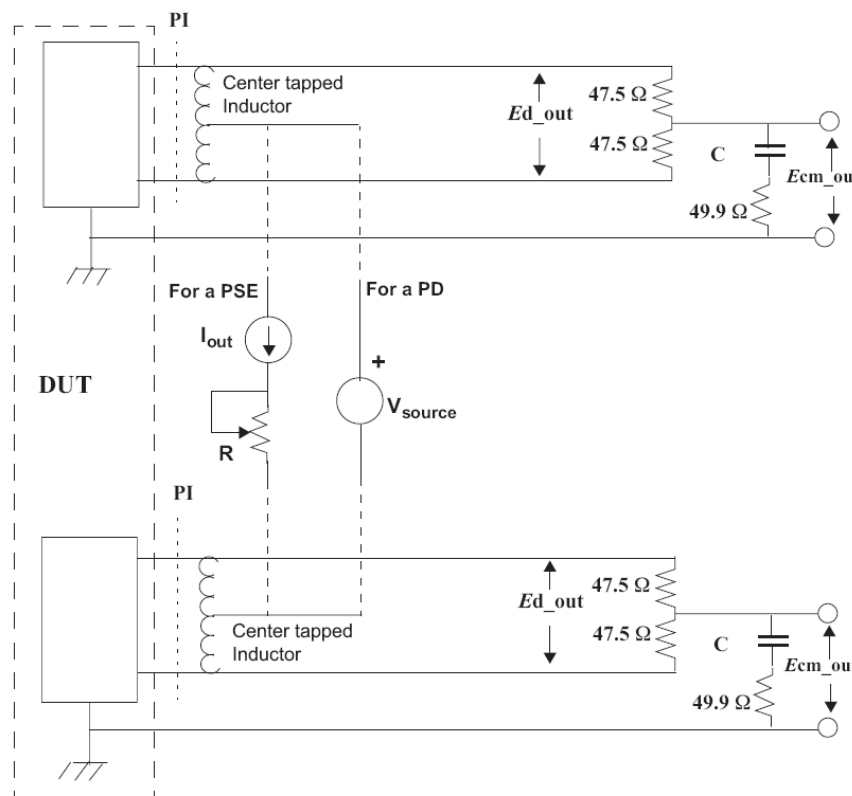


Figure 33–16—PSE and PD terminations for common-mode output voltage test

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Procedure:

1. Configure the device to transmit in 10 Mb/s
2. Using Smartbits, force the device to send data
3. Set up the DUT with the appropriate test jig
4. Measure the common mode AC output voltage
5. Repeat steps 1-4 with device transmitting at 100Mb/s

Observable Results:

- The magnitude of the common-mode AC output voltage, E_{cm_out} , shall not exceed 50 mV peak when operating at 10 Mb/s, and 50 mV peak-to-peak when operating at 100 Mb/s or greater.
- The magnitude of the common-mode AC voltage shall not exceed 50mV peak-to-peak measured at all other PIs.

Possible Problems: None